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USERS GUIDE FOR **SEALOADS:** A THREE-DIMENSIONAL NONLINEAR TIME-DOMAIN SEA LOADS PROGRAM

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Centre for Maritime Vessel Development and Research
DalTech

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by

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ABSTRACT

SEALOADS is a computer software package for the time-domain prediction of nonlinear ship motions, hydrodynamic hull pressures, and sea loads. This manual explains how to use the program.

The SEALOADS code consists of three modules. One module computes time-domain hydrodynamic coefficients and the impulsive response functions of the forces and pressures due to the radiated waves. Another module solves the time-domain response functions of the forces and pressures due to diffracted waves. The main program module computes ship motions, hydrodynamic pressure distribution on the ship hull, and sea loads in the time domain.

The SEALOAD code is written for use with a FreeBSD UNIX system. A flow chart and procedures for running the package are included. Input and output file structures are described in detail. Example files are also included in the report.

RÉSUMÉ

SEALOADS est un progiciel permettant la prédiction dans le domaine temporel des mouvements non linéaires de navires, des pressions hydrodynamiques exercées sur la coque et des charges de mer. Le présent manuel explique comment utiliser ce programme.

Le progiciel SEALOADS comprend trois modules. Un des modules calcule, dans le domaine temporel, les coefficients hydrodynamiques et les fonctions de réponse d'impulsion des forces et des pressions dues aux effets de rayonnement des vagues. Un autre module résout dans le domaine temporel les fonctions de réponse des forces et des pressions dues aux effets de diffraction des vagues. Le module du programme principal calcule, dans le domaine temporel, les mouvements du navire, la distribution des pressions hydrodynamiques exercées sur la coque et les charges de mer.

Le programme SEALOADS a été conçu pour être utilisé avec le système FreeBSD UNIX. Un organigramme et des instructions portant sur l'exploitation du progiciel sont inclus. Les structures des fichiers d'entrée et de sortie sont décrites en détail. Des exemples de fichiers sont aussi compris dans le rapport.

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1 Procedure for Running the Computer Program

The time-domain nonlinear motion, pressure and sealoads prediction software package, **SEALOADS**, consists of three programs, **rad.f**, **dif.f** and **sea.f**.

The program **rad.f** computes the time-domain hydrodynamic coefficients and the impulse response functions of forces and pressures due to the the radiated waves.

The program **dif.f** computes the time-domain impulse response functions of forces and pressures due to the diffracted waves.

The program **sea.f** computes the time-domain ship motions, pressure distribution over the ship hull and sealoads.

In order to run **sea.f**, two programs **rad.f** and **dif.f** have to be run first to solve the response functions. The program **sea.f** uses the output from **rad.f** and **dif.f**. The structure of the software package is shown in Fig. 1. For details of running these programs see the following sections.

1.1 Program rad.f

The program **rad.f** computes the time-domain hydrodynamic coefficients including added mass, damping and hydrodynamic restoring coefficients. The 3-D panel method is used in the computation.

Input data files are **shipname.par** and **shipname.pan** which are described in detail in Section 2.

Output data files are **kij.d**, **kijx.d** and **kij_pres.d** which will be used as the input files for the program **sea.f**. These files are automatically generated. The file **kij.d** contains the response functions of radiation force for the whole ship, while **kijx.d** contains the counterparts for the ship hull forward of Cx which is the x coordinate of the cross section. The data file **kij_pres.d** contains the response functions of pressures over the ship hull due to the radiated waves.

A flow chart of **rad.f** is shown in Fig. 2. It should be noted that the parameter **n_time0** represents the maximum number of time steps, and the parameter **npl** is the maximum number of panels on the port-side of the ship. In the current program, they are 150 and 160, respectively.

1.2 Program dif.f

The program **dif.f** is used to compute the response functions of forces and pressures due to the diffracted waves in the time domain. Computation is based on the three-dimensional panel method.

Input data files are **shipname.par** and **shipname.pan** which contain ship's principal characteristic, ship motion and wave information. The format of these files is described in Section 2 and examples are also included.

Output data file **ki7.d** contains the response function of forces due to diffracted waves for the whole ship hull, while **ki7x.d** contains the response function of forces due to the diffracted waves for the ship hull forward from Cx. The file **ki7_pres.d** contains the response functions of pressures over the ship hull due to the diffracted waves. These data files will be used by the program **sea.f** as the input files for sea load computation. All of these files are automatically generated by the program **dif.f**.

A flow Chart of **dif.f** is shown in Fig. 3.

1.3 Program sea.f

The program **sea.f** is for computing the time-domain ship motions, pressures and sea loads. Methods developed for this purpose have been discussed in the the theoretical manual of this work.

The input data files to **sea.f** are **adms.d, kij.d, kijx.d, kij_pres.d, ki7.d, ki7x.d, ki7_pres.d, shipname.wav, shipname.hul, shipname.man,** and **shipname.dam**.

Among them, the data files **adms.d, kij.d, kijx.d, kij_pres.d,** and **ki7.d, ki7x.d, ki7_pres.d** are automatically generated by **rad.f** and **dif.f**, while **shipname.wav, shipname.hul, shipname.man, shipname.sec** and **shipname.dam** have to be prepared by the user before running **sea.f**.

At present, there are several output data files which contain results for all the force components. These files are mainly used in checking for any errors in the code and will eventually be removed. The output file **shipname.mtd** contains the simulation results of ship motions in six-degrees-of-freedom. The file **shipname.pre** contains the results of pressure at the centroid of each panel. The file **shipname.sea** contains the two main components of sea loads at Cx. Details of the input and output data files are given in Sections 2 and 3, respectively.

A flow chart of **sea.f** is shown in Fig. 4.

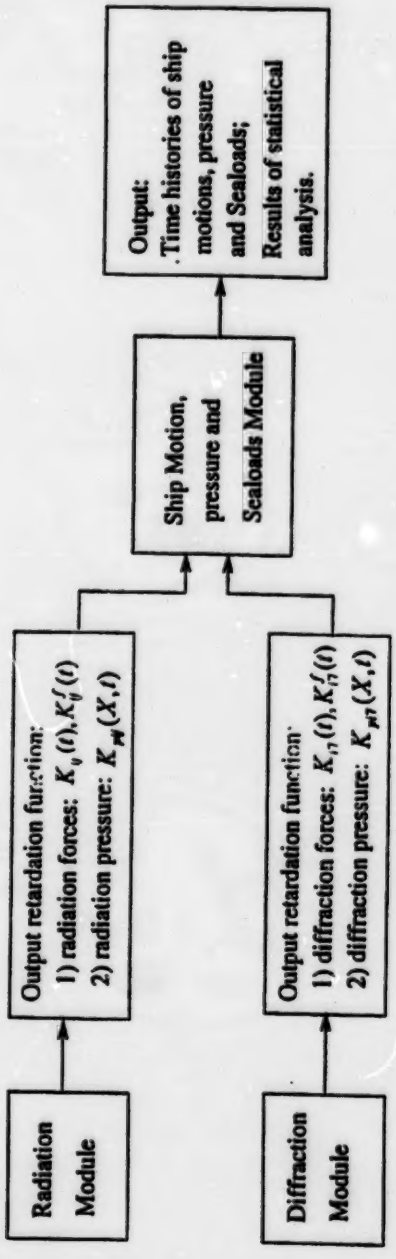

Fig. 1 Flow Chart of Running the Time-Domain Programs

Radiation Force Module

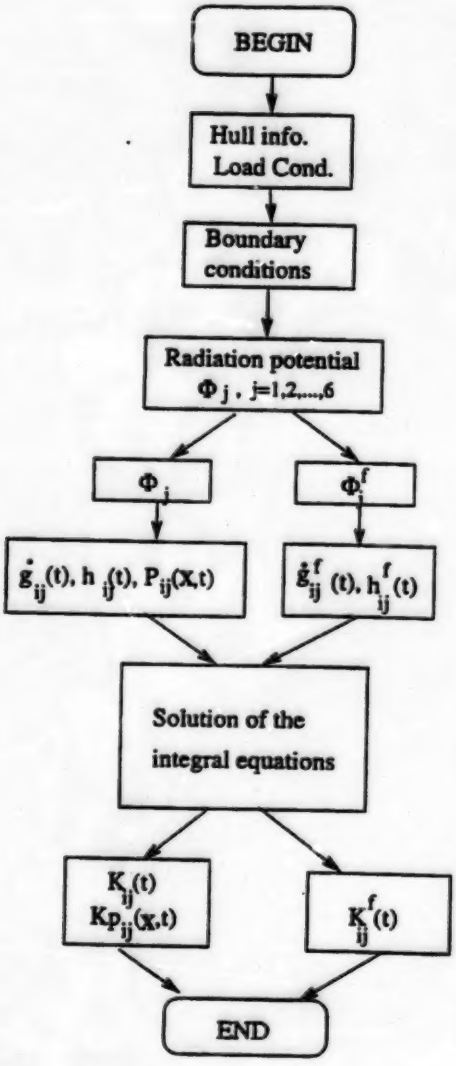

Fig. 2 Flow Chart of Program rad.f

Diffraction Force Module

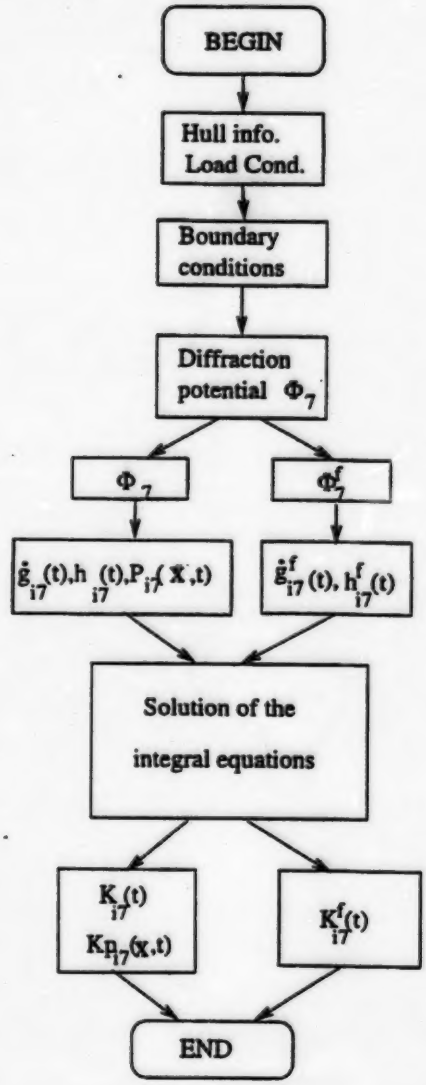

Fig. 3 Flow Chart of Program dif.f

Flow Chart of Motion and Seaload Module

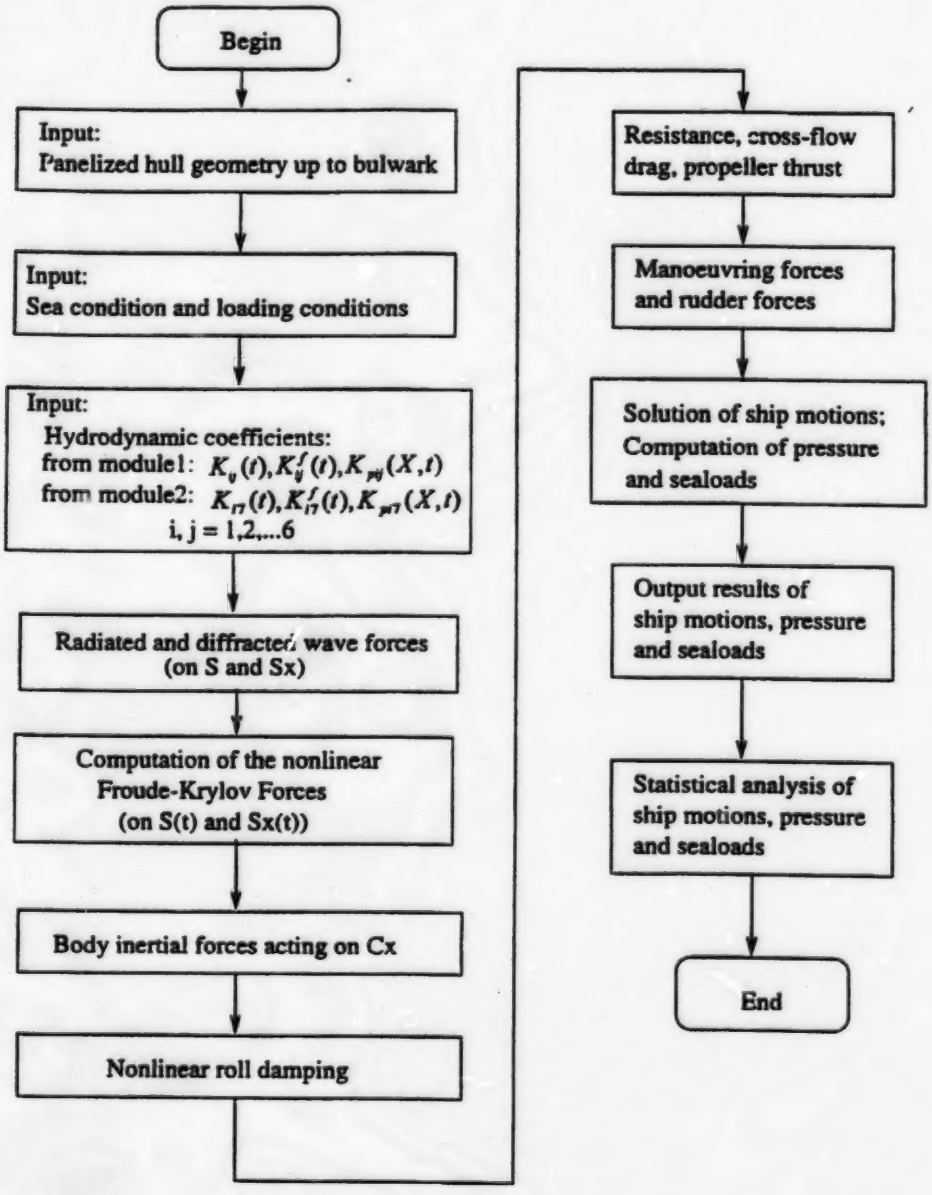

Fig. 4 Flow Chart of Program sea.f

2 Input Data Files

2.1 Input Data File: shipname.par

This file contains parameters for the ship hull, ship motion and waves.

Record(a), k_pres

k_pres : parameter of pressure computation
k_pres=0: pressure is not computed
k_pres=1: pressure is computed

Record(b), sl,sb,sd

sl : length of the ship (m)
sb : breadth of the ship (m)
sd : draft of the ship (m)

Record(c), f_n

f_n : Froude number

Record(d), abar

abar : nondimensional coefficient of the impulse function, the recommended value is 0.1

Record(e), dt, dt0

dt : time step for computing response functions (sec), the recommended value is 0.05
dt0 : time step for program **sea.f** (sec), suggestion: dt is 4 to 6 times dt0

Record(f), N_time

N_time : number of time steps (N_time$\leq$150)

Record(g), beta

beta : wave heading with respect to the x-axis (deg)

An example of the data file for the frigate CPF is given in Appendix A.

2.2 Input Data File: shipname.pan

The underwater surface of the port side of the hull is divided into a finite number of quadrilateral panels. The nodes are arranged in the order as shown in Figure 5. The panels are viewed from inside of the hull.

Record (a), xg, yg, zg (3 real numbers)

xg :	x-coordinate of the centre of gravity (m)
yg :	y-coordinate of the centre of gravity (m)
zg :	z-coordinate of the centre of gravity (m)

Record (b), np, ne, xcx, l (2 integers, 2 real numbers)

np :	number of nodes
ne :	number of panels
xcx :	x-coordinate of the forward section (m)
l :	ship length (m)

Record (c), (i, x(i), y(i), z(i)) (i=1, np) (1 integer, 3 real numbers)

1	x(1)	y(1)	z(1)
2	x(2)	y(2)	z(2)
..	..	..	..
I	x(I)	y(I)	z(I)
..	..	..	..
np	x(np)	y(np)	z(np)

I :	node index
x(I) :	nodal x-coordinates relative to midships (m)
y(I) :	nodal y-coordinates relative to centerline (m)
z(I) :	nodal z-coordinates relative to calm waterline (m)

Record (d), (i, j(1,i), j(2,i), j(3,i), j(4,i)) (i=1, ne) (5 integers)

1	j(1,1)	j(2,1)	j(3,1)	j(4,1)
2	j(1,2)	j(2,2)	j(3,2)	j(4,2)
..	..	..	..	..
J	j(1,J)	j(2,J)	j(3,J)	j(4,J)
..	..	..	..	..
ne	j(1,ne)	j(2,ne)	j(3,ne)	j(4,ne)

J : panel index

j(I,J) : connectivity information, providing four nodal indices on each panel. The nodes are arranged as shown in Figure 5.

An example of the data file for the frigate CPF is given in Appendix A.

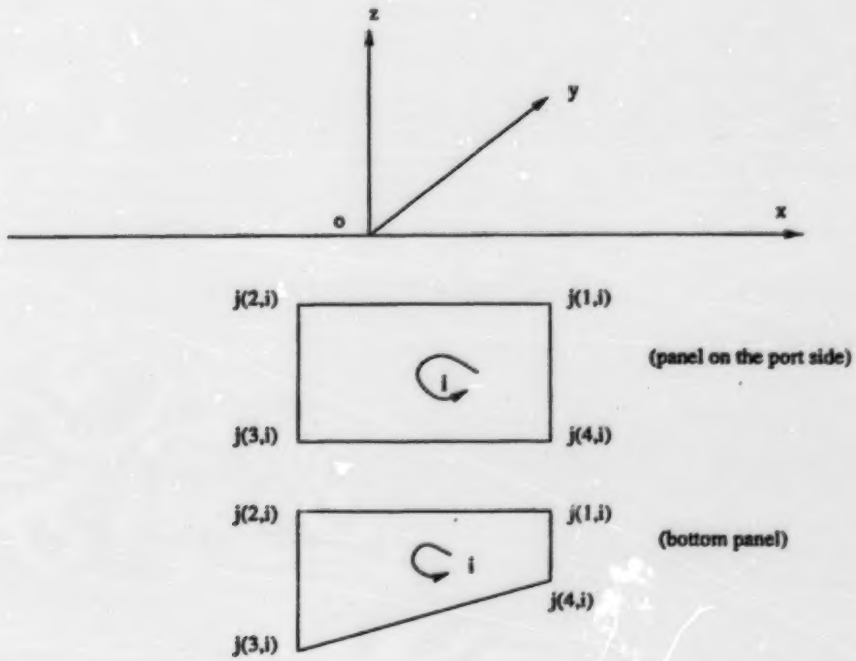

Fig. 5 Panels and Connectivity Information

2.3 Input Data File: shipname.wav

This data file contains the wave condition, forward speed, heading, viscous roll damping, and other parameters necessary for the time-domain motion simulation.

Record (a), i_type, k_pres (2 integers)

i_type defines the incident wave conditions:

$$\text{i_type} = \begin{cases} 0: & \text{regular wave} \\ 1: & \text{ISSC spectrum (2 parameters)} \\ 2: & \text{JONSWAP spectrum} \\ 3: & \text{Bretschneider spectrum} \\ 4: & \text{Ochi-Hubble six-parameter spectrum} \\ 5: & \text{measured spectrum} \\ 6: & \text{second-order Stokes waves} \end{cases}$$

k_pres is the parameter to control pressure computation defined in Appendix A.

$$\text{k_pres} = \begin{cases} 0: & \text{pressure is not computed} \\ 1: & \text{pressure is computed} \end{cases}$$

Record (b), wd (1 real number)

wd: water depth (m)

If $i_type \neq 6$, skip this record.

Record (c), headi (1 real number)

headi: incident wave heading (deg) with headi = 180 degrees for head seas.

Record (d), f_speed (1 real number)

f_speed: forward ship speed (knots).

Record (e1), h31, t1, eps (3 real numbers)

h31: wave amplitude (m)
t1: wave frequency (rad/sec)
eps: initial phase angle of the incident wave (deg)
If $i_type \neq 0$ or 6, skip this record.

Record (e2), h31, t1 (2 real numbers)

h31: significant wave height (m)
t1: 6.283 /fm (sec) where fm is the mean frequency of irregular waves
If *i_type* $\neq$ 1, 2 or 3, skip this record.

Record (e3), a1, b1, c1 a2, b2, c2 (6 real numbers)

a1, b1, c1, a2, b2, c2: parameters used in Ochi-Hubble six-parameter spectrum.
If *i_type* $\neq$ 4, skip this record.

Record (e4), nspec (1 integer)

nspec: number of measured wave spectral values
If *i_type* $\neq$ 5, skip this record.

Record (e5), w(i), spec(i), i=1, 2, $\cdots$, nspec (2 real numbers)

w(i): frequency (rad/sec)
spec(i): measured spectral value
If *i_type* $\neq$ 5, skip this record.

Record (f), nw, w1, w2 (1 integer, 2 real numbers)

nw: number of regular wave components in irregular wave
w1: lower frequency limit in the wave spectrum (rad/sec)
w2: upper frequency limit in the wave spectrum (rad/sec)
If *i_type* = 0 or 6, skip this record.

Record (g), nt, ntau, dt (2 integers, 1 real number)

nt: number of time steps used in time-domain motion simulation
ntau: number of time steps used in computing retardation function
dt: time step (sec).

Record (j), i_vsdmp, i_fdm, i_exp (3 integers)

i_vsdmp: control parameter which determines the choice of the following roll damping:

$$\text{i_}vsdmp = \begin{cases} 0: & \text{empirical formula} \\ 1: & \alpha_1\dot{\phi} + \alpha_2|\phi|\dot{\phi} \\ 2: & \alpha_1\dot{\phi} + \alpha_2|\phi|^2\dot{\phi} \\ 3: & \alpha_1\dot{\phi} + \alpha_2\dot{\phi}^3 \\ 4: & \alpha_1\dot{\phi} + \alpha_2|\dot{\phi}|\dot{\phi} \end{cases}$$

$$\text{i_}fdm = \begin{cases} 3: & \text{when heave, roll and pitch are computed} \\ 6: & \text{when motions in six-degrees-of-freedom are computed} \end{cases}$$

$$\text{i_}exp = \begin{cases} 0: & \text{when starting motion computation with ship at its rest position} \\ 1: & \text{when starting motion computation with a given initial condition} \end{cases}$$

Record (k), npsta, m, k (3 integers)

npsta: number of points in the time series of ship motions for spectral analysis.
m : 2^n, where n is an integer.
k : integer which satisfies $4mk < npsta$.

Record (l), b_vdm(1), b_vdm(2) (2 real numbers)

b_vdm(1), b_vdm(2): viscous roll damping coefficients α_1 and α_2
If i_vsdm = 0, skip this record.

An example of the data file for the frigate CPF is given in Appendix A.

2.4 Input Data File: shipname.hul

Record (a), L, B, T, rxx, ryy, rzz

L :	ship length between perpendiculars (m)
B :	ship beam (m)
T :	ship draught (m)
rxx :	roll radius of gyration of the ship (m)
ryy :	pitch radius of gyration of the ship (m)
rzz :	yaw radius of gyration of the ship (m)

Record (b), xg, yg, zg, V

xg :	x-coordinate of centre of garvity of the ship (m)
yg :	y-coordinate of centre of gravity of the ship (m)
zg :	z-coordinate of centre of gravity of the ship (m)
V :	volume displacement of the ship (m*m*m)

Record (c), NNP

NNP :	number of nodes on the port-side of the ship hull

Record (d), i, x(i), y(i), z(i) (i=1, NNP)

1	x(1)	y(1)	z(1)
2	x(2)	y(2)	z(2)
..	..	..	..
I	x(I)	y(I)	z(I)
..	..	..	..
np	x(np)	y(np)	z(np)

I :	node index
x(I) :	nodal x-coordinates relative to a midships (m)
y(I) :	nodal y-coordinates relative to centerline (m)
z(I) :	nodal z-coordinates relative to calm waterline (m)

Record (e), NP

NP : number of panels on port side of ship hull

Record (f), (i, j(1,i), j(2,i), j(3,i), j(4,i)) (i=1, ne)

1	j(1,1)	j(2,1)	j(3,1)	j(4,1)
2	j(1,2)	j(2,2)	j(3,2)	j(4,2)
..	..	..	..	..
J	j(1,J)	j(2,J)	j(3,J)	j(4,J)
..	..	..	..	..
NP	j(1,NNP)	j(2,NNP)	j(3,NNP)	j(4,NNP)

J : panel index

j(I,J) : connectivity information, providing four nodal indices on each panel. The nodes are arranged as shown in Figure 5.

Record (k), n_top

n_top: number of nodes on top of bulwark.

Record (l), i_top(j), j=1, 2, ..., n_top

i_top(j), j=1, 2,..., n_top: indices of nodes on top of bulwark.

An example of the data file for the Frigate CPF is given in Appendix A.

2.5 Input Data File: shipname.man

This file contains data for computing resistance, cross-flow drag, thrust, maneuvering force, rudder force, and the autopilot parameters.

Record (a), Control Parameters
i_resi, *i_cross*, *i_prop*, *i_manu*, *i_rud* (5 integers)

$$i_resi = \begin{cases} 0: & \text{resistance is not computed} \\ 1: & \text{resistance is computed using test data} \\ 2: & \text{resistance is computed using empirical formulae for CPF frigate} \end{cases}$$

$$i_cross = \begin{cases} 0: & \text{cross-flow drag is not computed} \\ 1: & \text{cross-flow drag is computed using test data} \\ 2: & \text{cross-flow drag is computed using empirical formulae} \end{cases}$$

$$i_prop = \begin{cases} 0: & \text{propeller thrust equals to the calm water resistance at forward speed } u_{,hip} \\ 1: & \text{propeller thrust is computed} \end{cases}$$

$$i_manu = \begin{cases} 0: & \text{maneuvering force is not computed} \\ 1: & \text{hydrodynamic derivatives are provided by user} \\ 2: & \text{empirical formulae are used to compute hydrodynamic derivatives} \end{cases}$$

$$i_rud = \begin{cases} 0: & \text{rudder force is not computed} \\ 1: & \text{rudder force is computed} \end{cases}$$

Record (b), Principal Characteristics of the Ship

sl, *sb*, *tm*, *ta*, *tf*, *vol*, *cb* (7 real numbers)

sl: overall ship length (m)
sb: ship breadth (m)
tm: mean draft at amidships (m)
ta: draft at aft perpendicular (m)
tf: draft at fore perpendicular (m)
vol: volume displacement (m^3)
cb: block coefficient

Record (c), Resistance Test Data

nr (1 integer)

nr : number of measured resistance data ($nr < 20$)

$ur(i)$, $resi(i)$ $(i = 1, 2, \ldots, nr)$ (2 real numbers)

$ur(i)$: ship's forward speed (m/sec)
$resi(i)$: resistance corresponding to $ur(i)$, (N)
If $i_resi \neq 1$, skip this record.

Record (d), Cross-Flow Drag Test Data

ncd (1 integer)

ncd : number of measured cross-flow drag data

$ucd(i)$, $drag1(i)$ $(i = 1, 2, \ldots, ncd)$ (2 real numbers)

$ucd(i)$: ship's transverse speed (m/sec)
$drag1(i)$: cross-flow drag corresponding to $ucd(i)$, (N).
If $i_cross \neq 1$, skip this record.

Record (e), Sectional Geometry for Cross-Flow Drag (see Fig.6)

$ndraft$ (1 integer)

$ndraft$: number of cross sections used in computing cross-flow drag

$xdraft(i)$, $draft(i)$ $(i = 1, 2, \ldots, ndraft)$ (2 real numbers)

$xdraft(i)$: x-coordinate of cross section i (m)
$draft(i)$: draft of cross section i (m)
If $i_cross \neq 2$, skip this record.

Record (f), Wake Factor and Thrust Deduction

w, t (2 real numbers)

w : wake fraction
t : thrust deduction fraction
If $i_prop \neq 1$, skip this record.

Record (g), Propeller Characteristics

d_prop, *prot* (2 real numbers)

d_prop : propeller diameter (m)
prot : propeller's RPM
If *i_prop* $\neq$ 1, skip this record.

Record (h), Propeller Hydrodynamics

nkt (1 integer)

nkt : number of input data points

$jt(i)$, $Kt(i)$, $Kq(i)$ $(i = 1, 2, \ldots, nkt)$ (3 real numbers)

$jt(i)$: advance ratio
$Kt(i)$: thrust coefficient
$Kq(i)$: torque coefficient
If *i_prop* $\neq$ 1, skip this record.

Record (i), Maneuvering Hydrodynamic Derivatives

Y_β, Y_r, $Y_{\beta\beta}$, $Y_{\beta\beta r}$, $Y_{\beta rr}$ (6 real numbers)

N_β, N_r, $N_{\beta\beta}$, $N_{\beta\beta r}$, $N_{\beta rr}$ (6 real numbers)

These are maneuvering hydrodynamic derivatives used in the following maneuvering force and turning moment equations.
Force:

$$\begin{aligned} F_2^H(t) &= \frac{1}{2}\rho L d U^2 [Y_\beta \beta' + Y_r r' + Y_{\beta\beta}|\beta'|\beta' \\ &\quad + Y_{rr}|r'|r' + (Y_{\beta\beta r}\beta' + Y_{\beta rr} r')\beta' r'] \end{aligned}$$

Moment:

$$\begin{aligned} F_6^H(t) &= \frac{1}{2}\rho L^2 d U^2 [N_\beta \beta' + N_r r' + N_{\beta\beta}|\beta'|\beta' \\ &\quad + N_{rr}|r'|r' + (N_{\beta\beta r}\beta' + N_{\beta rr} r')\beta' r'] \end{aligned}$$

where ρ is water density, L is ship length, d is ship draft, $\beta' = -u_2/U$, $r' = \dot{e}_6 L/U$, U is the ship's forward speed, $\dot{e}_6$ is the yaw rate and u_2 is the instantaneous sway velocity.

If $i_manu \neq 1$, skip this record.

Record (j), Rudder Geometry (see Fig.7)

Rb, *Rc*, *Rl*, *Xrc*, *Zrc*, *Ar*, (6 real numbers)

Rb : distance from the leading edge of rudder to the hull (m)
Rc : the rudder width (m)
Rl : aspect ratio of rudder
Xrc : horizontal distance from ship's C.G. to rudder's center R.C. (m)
Zrc : vertical distance from ship's C.G. to rudder's center R.C. (m)
Ar : rudder area (m^2)
If $i_rud \neq 1$, skip this record.

Record (k), Auto-pilot Parameters

a0_rud, *a1_rud*, *a2_rud*, *rud_0*, *rud_lim* (5 real numbers)

a0_rud: constant bias angle of the rudder (*deg*)
a1_rud: gain of yaw angle
a2_rud: gain of yaw rate
rud_0: threshold angle of yaw, beyond which the rudder is activated. (*deg*)
rud_lim: absolute value that the rudder is allowed to reach (*deg*)
If $i_rud \neq 1$, skip this record.

An example of the data file for the frigate CPF is given in Appendix A.

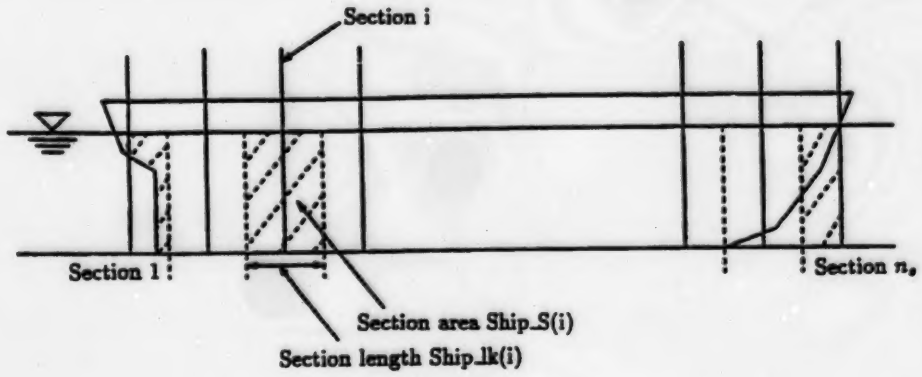

Fig. 6 Sectional Geometry for Cross-Flow Drag

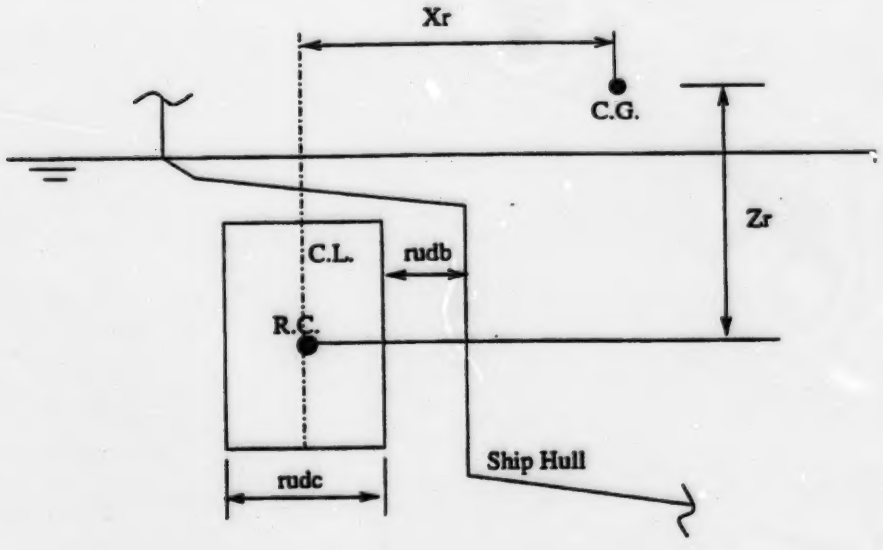

Fig.7 Rudder Geometry

2.6 Input Data File: shipname.dmp

When i_vsdm = 0 in the file "**shipname.wav**", empirical formulae are used to compute the roll damping. The input data file **shipname.dmp** provides all the necessary data to compute the bilge keel, eddy-making, friction, lifting, and appendage damping coefficients, where applicable, and also the resultant viscous damping coefficient.

Record (a), Control Parameters

IBK, *IBE*, *IBF*, *IBL* (4 integers)

IBK : if $IBK = 1$, the bilge keel viscous roll damping coefficient is computed; if $IBK = 0$, the bilge keel viscous roll damping coefficient is not computed.

IBE : if $IBE = 1$, the eddy-making viscous roll damping coefficient is computed; if $IBE = 0$, the eddy-making viscous roll damping coefficient is not computed.

IBF : if $IBF = 1$, the friction viscous roll damping coefficient is computed; if $IBF = 0$, the friction viscous roll damping coefficient is not computed.

IBL : if $IBL = 1$, the lifting viscous roll damping coefficient of rudder and skeg is computed; if $IBL = 0$, the lifting viscous roll damping coefficient of rudder and skeg is not computed.

Record (b), Ship Parameters

ns, *ns*0, *ns*1 (3 integers)

ns : total number of sections
*ns*0 : index of the section where the bilge keel starts
*ns*1 : index of the section where the bilge keel ends
NOTE: If bilge keel is not considered, that is IBK=0, then set $ns0 = ns1 = 0$.

Record (c), Water Properties
rho, *mu* (2 real numbers)

rho : density of water (kg/(m*m*m))
mu : kinematic viscosity of water (m*m/s)

Record (d), Bilge Keel Information

b_k, *bk_1* (2 real numbers)

b_k:	bilge keel breadth (m)
bk_1:	bilge breadth-length ratio

NOTE: If bilge keel is not considered, that is IBK=0, then set $b_k = bk_1 = 0$.

If IBE=1, Record (e1) has the following format:
Record (e1), Sectional Parameters

For sections $i = 1, 2, ..., ns$:
Ship_I(i), *Ship_S*(i), *Ship_B*(i), *Ship_KG*(i), *Ship_d*(i), *Ship_d*
(1 integer, 4 real numbers)

Ship_I(i):	the sectional shape identifier for V or U-shaped section, $Ship_I = 1$ for full, almost rectangular section $Ship_I = 2$ for triangular section, $Ship_I = 3$
Ship_S(i):	wetted hull surface area at section i (m*m) (Figure 6)
Ship_B(i):	sectional beam (m)
Ship_KG(i):	height of ship's C.G. above the lowest point at each section (m)
Ship_d(i):	sectional draught (m)

If IBE=2, Record (e1) has the following format:
Record (e1), Sectional Parameters

For sections $i = 1, 2, ..., ns$:
Ship_I(i), *Ship_S*(i), *Ship_B*(i), *Ship_KG*(i), *Ship_d*(i), *Ship_d Ship_section*(i)
(1 integer, 5 real numbers)

Ship_I(i):	the sectional shape identifier for V or U-shaped section, $Ship_I = 1$ for full, almost rectangular section $Ship_I = 2$ for triangular section, $Ship_I = 3$
Ship_S(i):	wetted hull surface area at section i (m*m) (Figure 6)
Ship_B(i):	sectional beam (m)
Ship_KG(i):	height of ship's C.G. above the lowest point at each section (m)
Ship_d(i):	sectional draught (m)
Ship_section(i):	cross-section area (m*m)

NOTE: If $IBE \neq 1$ and $IBE \neq 2$, skip Record (e1)

Record (e2), Sectional Parameters

For sections $i = 1$ to ns:

Ship_rhat(i), *Ship_a(i)*, *Ship_r(i)*, *Ship_rb(i)*, *Ship_lk(i)* (5 real numbers)

Ship_rhat(i): distance from ship's C.G. to the point where eddies are shed, in yz plane (m).
Ship_a(i): the inclination angle of ship side at the section waterline (deg) (Figure 8).
Ship_r(i): distance from ship's C.G. to the center of the bilge keel at each section (m); if no bilge keel, set value to zero.
Ship_rb(i): section bilge radius (m) (Figure 8).
Ship_lk(i): section length (m) (Figure 6).

Record (e3), Sectional Parameters

For sections $i = 1$ to ns:

Ship_G(i), *Ship_ss(i)*, *Ship_F_r(i)*, *Ship_a_g(i)* (4 real numbers)

Ship_G(i): angle between waterlines, from ship's C.G. to the bilge keel root and design waterline (rad) (Figure 9).
Ship_ss(i): length of girth from the bilge keel root to design waterline (m) (Figure 9).
Ship_F_r(i): sectional deadrise (m) (Figure 8).
Ship_a_g(i): the angle made by the plane of the bilge keel with the straight line passing through C.G. and the bilge keel root (rad) (Figure 9).

NOTE: If there is no bilge, all parameters in this section are zeros.

Record (f), Rudder and Deadwood Parameters

b_s, *h_CG*, *b_R*, *sigma*, *S_R* (5 real numbers)

b_s: skeg span (m) (Figure 10).
h_CG: vertical distance of ship's C.G. above waterline (m) (Figure 10).
b_R: rudder span (m) (Figure 10).
sigma: skeg angular parameter (rad) (Figure 10).
S_R: rudder area of single side (m*m).

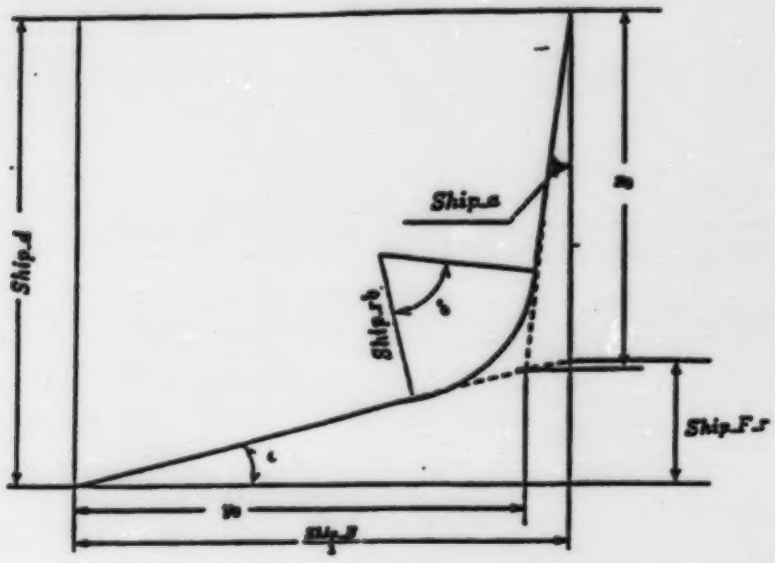

Fig. 8 Sectional Parameters

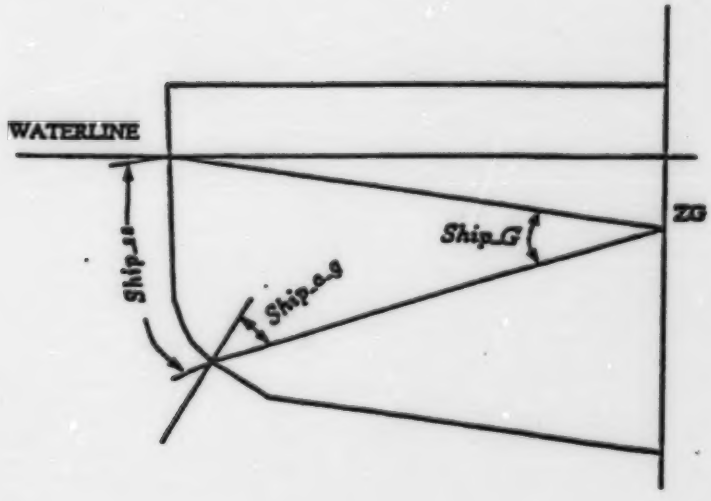

Fig. 9 Bilge Keel Parameters

Record (g1), Parameters of Appendages Other Than Bilge Keel

na, c_n (1 integer, 1 real number)

na: total number of appendages.
c_n: normal force coefficient for a flat plate inclined at a large angle to the flow.

Record (g2), Parameters of Appendages Other than Bilge Keel

For appendage $i = 1$ to *na*:

App_y(i), *App_z*(i), *App_G*(i), *App_C_e*(i), *App_C_r*(i), *App_Bar_B*(i) (6 real numbers)

App_y(i): y-coordinate of appendage i (m) (Figure 11).
App_z(i): z-coordinate of appendage i (m) (Figure 11).
App_G(i): appendage dihedral angle (deg) (Figure 11)
App_C_e(i): end chord of appendage i (m) (Figure 12).
App_C_r(i): root chord of appendage i (m) (Figure 12).
App_Bar_B(i): span of appendage i (m) (Figure 12).

An example of the data file for the frigate CPF is given in Appendix A.

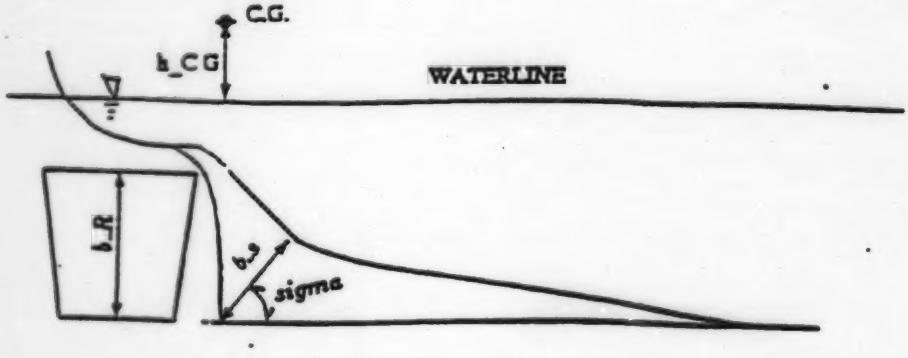

Fig. 10 Skeg and Rudder Parameters

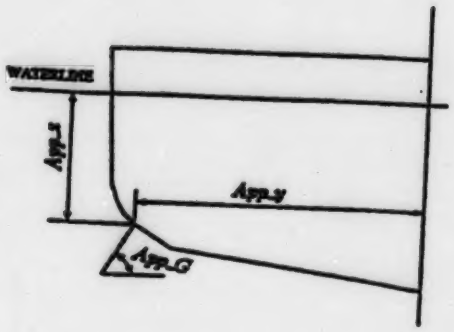

Fig. 11 Appendage Parameters

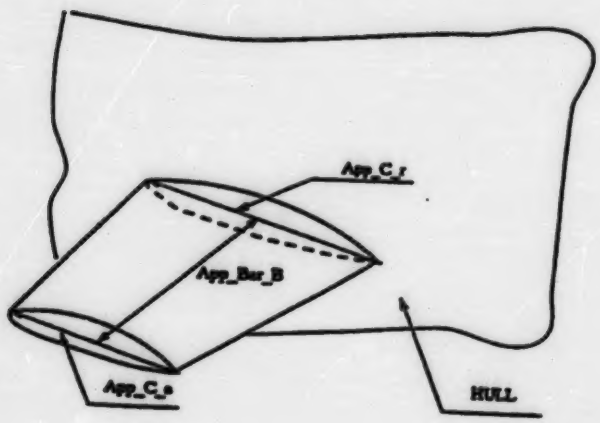

Fig. 12 Appendage Parameter

2.7 Input Data File: shipname.sec

shipname.sec provides the principal characteristics of the ship hull forward of Cx for sea load computation.

Record(a), xg, zg, cxg, czg, xc, rxx, ryy, a1

xg :	x-coordinate of C.G. of the ship (m)
zg :	z-coordinate of C.G. of the ship (m)
cxg :	x-coordinate of C.G. of the ship forward of Cx (m)
czg :	z-coordinate of C.G. of the ship forward of Cx (m)
xc :	x-coordinate of the centre of buoyancy of the ship forward of Cx (m)
rxx :	radius of inertia of the ship forward of Cx about x-axis (m)
ryy :	radius of inertia of the ship forward of Cx about y-axis (m)
a1 :	the mass of the ship forward of Cx (kg)

An example of the data file for the frigate CPF is given in Appendix A.

3 Output Data Files

3.1 Output Data File: shipname.mtd

The output data file **shipname.mtd** contains the time series of the computed ship motions. There are seven columns in this data file. They are: t, $\zeta_1(t)$, $\zeta_2(t)$, $\zeta_3(t)$, $e_1(t)$, $e_2(t)$, $e_3(t)$ for columns 1, 2, 3, 4, 5, 6, and 7 respectively. The physical meanings of the variables are:

t:	time (sec)
$\zeta_1(t)$:	surge (m)
$\zeta_2(t)$:	sway (m)
$\zeta_3(t)$:	heave (m)
$e_1(t)$:	roll angle (deg)
$e_2(t)$:	pitch angle (deg)
$e_3(t)$:	yaw angle of (deg)

An example of the computed time history of motions for the frigate CPF hull is given in Appendix A.

3.2 Output Data File: shipname.pre

The output data file **shipname.pre** contains the time series of the computed pressure distribution over the ship hull. There are $(N_p + 1)$ columns in this data file, where N_p is the number of panels used by the programs **rad.f** and **dif.f**. They are: t, (p_t(i),i=1,2,...,N_p) The physical meanings of the variables are:

t:	time (sec)
p_t(i):	pressure at the centroid of the i^{th} panel (pa)

An example of the computed time history of pressure for the frigate CPF hull is given in Appendix A.

3.3 Output Data File: shipname.sld

The output data file **shipname.sld** contains the time series of the computed sea loads on a ship's hull. There are three columns in this data file. They are: t, $fsld_3(t)$, $fsld_5(t)$, for columns 1, 2, 3, respectively. The physical meanings of the variables are:

t:	time (sec)
$fsld_3(t)$:	vertical shear force (N)
$fsld_5(t)$:	vertical bending moment (N-m)

An example of the computed time history of sea loads for the frigate CPF hull is given in Appendix A.

4 Appendix A: Examples of Input and Output Data Files

```
1
125.0 14.89 5.00   !sl  sb  st
0.05018    ! Fn
0.10    ! abar
0.30  0.05  1    ! dt  dt0  nlong
150   ! time steps (<150)
180.0   ! beta
```

```
-2.783    0.0   1.318
182 153   0.0   125.0
    1        58.9690        0.0000        -4.0000
    2        56.2500        0.0000        -4.7370
    3        56.2500        0.2741        -4.0457
    4        59.6344        0.0000        -3.5689
    5        56.2500        0.4137        -3.3282
    6        60.2498        0.0000        -3.0691
    7        56.2500        0.5583        -2.6283
    8        60.8087        0.0000        -2.5067
    9        56.2500        0.7413        -1.9542
   10        61.3122        0.0000        -1.8941
   11        56.2500        0.9214        -1.2961
   12        61.7772        0.0000        -1.2516
   13        56.2500        1.0257        -0.6387
   14        62.2430        0.0000        -0.6097
   15        56.2500        1.1400         0.0000
   16        62.7500        0.0000         0.0000
   17        50.0000        0.0000        -5.0000
   18        50.0000        0.5273        -4.3374
   19        50.0000        0.9097        -3.6017
   20        50.0000        1.2248        -2.8538
   21        50.0000        1.5091        -2.1133
   22        50.0000        1.7829        -1.3886
   23        50.0000        2.0552        -0.6831
   24        50.0000        2.3340        -0.0000
   25        43.7500        0.0000        -5.0000
   26        43.7500        0.7625        -4.4662
   27        43.7500        1.3431        -3.7529
   28        43.7500        1.8367        -3.0005
   29        43.7500        2.2658        -2.2327
   30        43.7500        2.6669        -1.4729
   31        43.7500        3.0533        -0.7285
   32        43.7500        3.4260         0.0000
   33        37.5000        0.0000        -5.0000
   34        37.5000        0.9463        -4.5634
   35        37.5000        1.7479        -3.9253
   36        37.5000        2.4305        -3.1917
   37        37.5000        3.0255        -2.4135
   38        37.5000        3.5474        -1.6115
   39        37.5000        4.0228        -0.8073
   40        37.5000        4.4460         0.0000
   41        31.2500        0.0000        -5.0000
   42        31.2500        1.0986        -4.6502
   43        31.2500        2.1019        -4.1113
   44        31.2500        2.9962        -3.4481
   45        31.2500        3.7564        -2.6716
   46        31.2500        4.3869        -1.8174
   47        31.2500        4.9111        -0.9218
   48        31.2500        5.3300         0.0000
   49        25.0000        0.0000        -5.0000
   50        25.0000        1.2528        -4.7489
   51        25.0000        2.4075        -4.2736
   52        25.0000        3.4702        -3.6742
   53        25.0000        4.4168        -2.9525
   54        25.0000        5.1683        -2.0620
   55        25.0000        5.6825        -1.0460
   56        25.0000        6.0570        -0.0000
   57        18.7500        0.0000        -5.0000
   58        18.7500        1.3631        -4.7808
   59        18.7500        2.6699        -4.4414
   60        18.7500        3.8822        -3.9191
   61        18.7500        4.9541        -3.2046
   62        18.7500        5.7777        -2.2566
   63        18.7500        6.3031        -1.1561
   64        18.7500        6.6220         0.0000
   65        12.5000        0.0000        -5.0000
   66        12.5000        1.4373        -4.7661
   67        12.5000        2.8393        -4.5116
   68        12.5000        4.1656        -4.0887
   69        12.5000        5.3198        -3.3723
   70        12.5000        6.2359        -2.4173
   71        12.5000        6.7586        -1.2395
```

72	12.5000	7.0200	-0.0000
73	6.2500	0.0000	-5.0000
74	6.2500	1.4848	-4.7614
75	6.2500	2.9304	-4.4869
76	6.2500	4.3271	-4.1552
77	6.2500	5.5422	-3.4672
78	6.2500	6.4942	-2.4956
79	6.2500	7.0408	-1.2878
80	6.2500	7.2670	0.0000
81	0.0000	0.0000	-5.0000
82	0.0000	1.5113	-4.7569
83	0.0000	2.9827	-4.4778
84	0.0000	4.4094	-4.1598
85	0.0000	5.6831	-3.5280
86	0.0000	6.6390	-2.5463
87	0.0000	7.1783	-1.3103
88	0.0000	7.3980	0.0000
89	-6.2500	0.0000	-5.0000
90	-6.2500	1.5198	-4.7553
91	-6.2500	2.9996	-4.4751
92	-6.2500	4.4352	-4.1580
93	-6.2500	5.7306	-3.5501
94	-6.2500	6.7010	-2.5691
95	-6.2500	7.2327	-1.3193
96	-6.2500	7.4460	0.0000
97	-12.5000	0.0000	-5.0000
98	-12.5000	1.5124	-4.7559
99	-12.5000	2.9852	-4.4776
100	-12.5000	4.4091	-4.1390
101	-12.5000	5.6891	-3.5128
102	-12.5000	6.6526	-2.5370
103	-12.5000	7.2128	-1.3079
104	-12.5000	7.4460	0.0000
105	-18.7500	0.0000	-5.0000
106	-18.7500	1.4887	-4.7523
107	-18.7500	2.9298	-4.4284
108	-18.7500	4.3205	-4.0398
109	-18.7500	5.5995	-3.4521
110	-18.7500	6.5655	-2.4883
111	-18.7500	7.1450	-1.2878
112	-18.7500	7.3900	0.0000
113	-25.0000	0.0000	-5.0000
114	-25.0000	1.3878	-4.5302
115	-25.0000	2.7722	-4.1598
116	-25.0000	4.1259	-3.8006
117	-25.0000	5.3718	-3.2392
118	-25.0000	6.3970	-2.3981
119	-25.0000	6.9899	-1.2441
120	-25.0000	7.2600	0.0000
121	-31.2500	0.0000	-5.0000
122	-31.2500	1.0569	-4.0643
123	-31.2500	2.3656	-3.6347
124	-31.2500	3.6889	-3.3639
125	-31.2500	4.9367	-2.9371
126	-31.2500	5.9992	-2.2076
127	-31.2500	6.7102	-1.1742
128	-31.2500	7.0630	0.0000
129	-37.5000	0.0000	-4.4830
130	-37.5000	0.8171	-3.4433
131	-37.5000	1.9957	-2.9258
132	-37.5000	3.2421	-2.6973
133	-37.5000	4.4425	-2.3990
134	-37.5000	5.5324	-1.8902
135	-37.5000	6.3525	-1.0530
136	-37.5000	6.8110	0.0000
137	-43.7500	0.0000	-3.1200
138	-43.7500	0.9953	-2.5491
139	-43.7500	2.0720	-2.2350
140	-43.7500	3.1512	-2.0274
141	-43.7500	4.1998	-1.7964
142	-43.7500	5.1921	-1.4590
143	-43.7500	6.0182	-0.8669
144	-43.7500	6.5120	0.0000

145	-50.0000	0.0000	-2.0300
146	-50.0000	1.0062	-1.8460
147	-50.0000	1.9935	-1.6831
148	-50.0000	2.9580	-1.5187
149	-50.0000	3.8988	-1.3493
150	-50.0000	4.8004	-1.1059
151	-50.0000	5.5902	-0.6745
152	-50.0000	6.1170	0.0000
153	-56.2500	0.0000	-1.3300
154	-56.2500	0.9368	-1.2656
155	-56.2500	1.8531	-1.1994
156	-56.2500	2.7487	-1.1311
157	-56.2500	3.6209	-1.0326
158	-56.2500	4.4664	-0.8927
159	-56.2500	5.2358	-0.5766
160	-56.2500	5.8070	0.0000
161	-59.3750	0.0000	-1.0940
162	-59.3750	0.8992	-1.0670
163	-59.3750	1.7777	-1.0151
164	-59.3750	2.6363	-0.9575
165	-59.3750	3.4763	-0.9177
166	-59.3750	4.2923	-0.8298
167	-59.3750	5.0456	-0.5674
168	-59.3750	5.5700	0.0000
169	-61.7000	0.0000	-0.9375
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172	-61.7499	2.5530	-0.8436
173	-61.7821	3.3646	-0.7846
174	-61.8281	4.1546	-0.6980
175	-61.9254	4.9065	-0.5148
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179	-62.2000	1.7214	-0.0000
180	-62.2000	2.5530	-0.0000
181	-62.2000	3.3646	-0.0000
182	-62.2000	4.1546	-0.0000

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97	111	119	118	110
98	112	120	119	111
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151	173	181	180	172
152	174	182	181	173
153	176	182	174	175

```
  0       1    ! wave type,    k_pres
  180.0   ! wave angle
  3.404     ! ship speed (knots)
1.482       0.645     0 ! h31=wave elev., t1=frequency, rn(0)=0.0
  3000   900 0.05   ! nt, ntau, dt
  0   6 0             ! i_vsdmp, i_fdm, i_exp
  512 64 2          ! npsta, msta, ksta
  0.0    0.0
```

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125.0 14.89 5.00 5.182 31.125 31.125
-2.780 0.0 1.318 4561.0
375
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    2        56.2500          0.0000          -4.7370
    3        56.2500          0.2759          -4.0384
    4        59.6344          0.0000          -3.5689
    5        56.2500          0.4163          -3.3136
    6        60.2498          0.0000          -3.0691
    7        56.2500          0.5636          -2.6069
    8        60.8087          0.0000          -2.5067
    9        56.2500          0.7403          -1.9577
   10        61.3122          0.0000          -1.8941
   11        56.2500          0.9184          -1.3090
   12        61.7772          0.0000          -1.2516
   13        56.2500          1.0250          -0.6452
   14        62.2430          0.0000          -0.6097
   15        56.2500          1.1400           0.0000
   16        62.7500          0.0000           0.0000
   17        50.0000          0.0000          -5.0000
   18        50.0000          0.5318          -4.3302
   19        50.0000          0.9165          -3.5862
   20        50.0000          1.2340          -2.8304
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   22        50.0000          1.7776          -1.4027
   23        50.0000          2.0524          -0.6900
   24        50.0000          2.3340          -0.0000
   25        43.7500          0.0000          -5.0000
   26        43.7500          0.7690          -4.4594
   27        43.7500          1.3540          -3.7376
   28        43.7500          1.8512          -2.9767
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   31        43.7500          3.0495          -0.7358
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   33        37.5000          0.0000          -5.0000
   34        37.5000          0.9551          -4.5575
   35        37.5000          1.7633          -3.9112
   36        37.5000          2.4504          -3.1680
   37        37.5000          3.0225          -2.4177
   38        37.5000          3.5377          -1.6274
   39        37.5000          4.0184          -0.8154
   40        37.5000          4.4460           0.0000
   41        31.2500          0.0000          -5.0000
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   43        31.2500          2.1215          -4.0990
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   47        31.2500          4.9064          -0.9308
   48        31.2500          5.3300           0.0000
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   50        25.0000          1.2652          -4.7453
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   52        25.0000          3.5017          -3.6535
   53        25.0000          4.4125          -2.9572
   54        25.0000          5.1566          -2.0814
   55        25.0000          5.6781          -1.0563
   56        25.0000          6.0570          -0.0000
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   64        18.7500          6.6220           0.0000
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85	0.0000	5.6767	-3.5321
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189	62.7500	2.2475	5.9651
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208	43.7500	7.3380	7.1400
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212	37.5000	7.7640	6.8710
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283	-63.3321	0.8788	2.8274
284	-63.3321	0.0000	2.8274
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286	-63.9762	0.0000	4.4215
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331

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226

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4	65.6250	2.5000	7.7500
5	62.7500	4.4500	8.6000
6	62.7500	3.5250	7.6800
7	56.2500	6.1400	8.5000
8	56.2500	5.3750	7.6250
9	50.0000	7.1500	8.2500
10	50.0000	6.5900	7.4260
11	43.7500	7.6300	8.0000
12	43.7500	7.3380	7.1400
13	37.5000	8.0000	7.7000
14	37.5000	7.7640	6.8710
15	18.7500	8.1330	6.2400
16	18.7500	8.2000	7.0000
17	12.5000	8.2000	7.0000
18	12.5000	8.1830	6.1910
19	6.2500	8.2000	7.0000

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26	-43.7500	7.5480	6.1460
27	-50.0000	7.3400	7.0000
28	-50.0000	7.2780	6.1640
29	-56.2500	7.0600	7.0000
30	-56.2500	6.9590	6.1840
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34	-64.7000	6.3300	6.2000
35	-64.7000	0.0000	6.2000
36	-65.0250	0.0000	7.0000
37	-65.0250	0.8701	7.0000
38	-64.7000	0.8701	6.2000
39	-65.0250	1.7214	7.0000
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43	-65.0250	3.3646	7.0000
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45	-65.0250	4.1546	7.0000
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47	-65.0250	4.9065	7.0000
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49	-65.0250	5.4380	7.0000
50	-64.7000	5.4380	6.2000
51	37.5000	0.0000	6.8710
52	43.7500	0.0000	7.1400
53	43.7500	1.8345	7.1400
54	37.5000	1.9410	6.8710
55	43.7500	3.6690	7.1400
56	37.5000	3.8820	6.8710
57	43.7500	5.5035	7.1400
58	37.5000	5.8230	6.8710
59	50.0000	0.0000	7.4260
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61	50.0000	3.2950	7.4260
62	50.0000	4.9425	7.4260
63	56.2500	0.0000	7.6250
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65	56.2500	2.6875	7.6250
66	56.2500	4.0312	7.6250
67	62.7500	0.0000	7.6800
68	62.7500	0.8813	7.6800
69	62.7500	1.7625	7.6800
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71	65.6250	0.0000	7.7500
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73	69.7500	0.1000	7.7640
74	37.5000	2.0000	7.7000
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177

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137	189	21	22	190
138	186	185	191	192
139	185	188	193	191
140	188	190	194	193
141	190	22	195	194
142	192	191	196	197
143	191	193	198	196
144	193	194	199	198
145	194	195	200	199
146	197	196	178	179
147	196	198	180	178
148	198	199	181	180
149	199	200	182	181
150	183	201	202	184
151	184	202	203	187
152	187	203	204	189
153	189	204	24	21
154	201	205	206	202
155	202	206	207	203
156	203	207	208	204
157	204	208	26	24

```
   158   205   209   210   206
   159   206   210   211   207
   160   207   211   212   208
   161   208   212    28    26
   162   209   213   214   210
   163   210   214   215   211
   164   211   215   216   212
   165   212   216    30    28
   166   213   217   218   214
   167   214   218   219   215
   168   215   219   220   216
   169   216   220    32    30
   170   217    35   221   218
   171   218   221   222   219
   172   219   222   223   220
   173   220   223    34    32
   174    35    36   224   221
   175   221   224   225   222
   176   222   225   226   223
   177   223   226    33    34
32
334 335 336 337 338 339
340 341 333 332 331 330
329 328 327 326 325 324
323 322 321 320 319 318
317 316 315 314 313 312
311 310
```

```
2   2    0    2    1
125.0   14.89    5.0    5.0    5.0    4619.5    0.496
22
        -62.2000          0.0000
        -61.7000          0.9375
        -59.3750          1.0940
        -56.2500          1.3300
        -50.0000          2.0300
        -43.7500          3.1200
        -37.5000          4.4830
        -31.2500          5.0000
        -25.0000          5.0000
        -18.7500          5.0000
        -12.5000          5.0000
         -6.2500          5.0000
          0.0000          5.0000
          6.2500          5.0000
         12.5000          5.0000
         18.7500          5.0000
         25.0000          5.0000
         31.2500          5.0000
         37.5000          5.0000
         43.7500          5.0000
         50.0000          5.0000
         62.7500          0.0000
5.0    3.415    1.552    59.291    4.515    19.00
0.00   1.0    0.0    0.0     35.0
```

```
     1       1       1       0       1
     21      6      14
     1024.   1.14E-06
     0.8     0.01606
     3       0       0    1.87    0.37
     3   74.07   11.61    2.83    1.33
     3   82.09   12.35    3.53    2.03
     3   92.13   13.02    4.62    3.12
     1  104.24   13.62    5.98   4.483
     1  115.14   14.13     6.5       5
     1  118.72   14.52     6.5       5
     1  122.43   14.78     6.5       5
     1  124.29   14.89     6.5       5
     1  124.29   14.89     6.5       5
     1  124.06   14.80     6.5       5
     1  122.09   14.53     6.5       5
     1  118.15   14.04     6.5       5
     1  111.72   13.24     6.5       5
     1  103.33   12.11     6.5       5
     1   93.47   10.66     6.5       5
     1   83.93    8.89     6.5       5
     1   74.26    6.85     6.5       5
     3   61.42    4.67     6.5       5
     3   61.37    2.51    6.37    4.87
     3       0       0    1.87    0.37
  1.87       0    0.06       0   3.113
  2.83    38.7    0.06       0   6.225
  3.53    32.6    0.06       0   6.225
  4.62    25.8    0.06       0   6.225
  5.98    21.0    0.06       0   6.225
   6.9    13.0    7.11     2.5   6.225
  7.26     8.0    7.61    2.66   6.225
  7.52     7.0    7.86     2.6   6.225
  7.61     4.0    7.96    2.73   6.225
  7.66     4.0    8.06     2.8   6.225
  7.66     6.0    8.06    2.86   6.225
  7.52     7.5    7.86     2.8   6.225
  6.86     9.0    7.26     2.7   6.225
  6.53    14.0    6.88     2.5   6.225
   6.5    19.0    0.06       0   6.225
   6.5    29.8    0.06       0   6.225
   6.5    31.6    0.06       0   6.225
   6.5    28.5    0.06       0   6.225
   6.5    21.4    0.06       0   6.225
  6.37    18.9    0.06       0    6.31
  1.87       0    0.06       0   3.113
 0.419       0       0   0.262
 0.419       0       0   0.262
 0.419       0       0   0.262
 0.419       0       0   0.262
 0.419       0       0   0.262
 0.419    3.44   1.234   0.262
 0.422    3.59   1.271   0.262
 0.427    3.71   1.292   0.261
 0.436    3.75   1.304    0.26
 0.436    3.77   1.304    0.26
 0.419    3.71   1.294   0.253
  0.41    3.63   1.273    0.25
 0.401    3.42   1.227    0.25
 0.383    2.99   1.153    0.25
 0.383       0       0    0.25
 0.383       0       0    0.25
 0.383       0       0    0.25
 0.383       0       0    0.25
 0.383       0       0    0.25
 0.383       0       0    0.25
 0.383       0       0    0.25
5.2 1.318   5.3 0.96666 19.00
0 0.
```

```
-2.690  1.290  24.786      1.236     0.0   5.882   29.000  2166196
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47.5000	-.1192E+02	.2625E-02	-.4799E+00	-.1477E-02	.2360E+01	-.3086E-02
47.5500	-.1193E+02	.2628E-02	-.4915E+00	-.1425E-02	.2316E+01	-.3102E-02
47.6000	-.1194E+02	.2631E-02	-.5022E+00	-.1371E-02	.2267E+01	-.3118E-02
47.6500	-.1195E+02	.2634E-02	-.5118E+00	-.1316E-02	.2214E+01	-.3134E-02
47.7000	-.1196E+02	.2637E-02	-.5203E+00	-.1260E-02	.2158E+01	-.3149E-02
47.7500	-.1196E+02	.2641E-02	-.5277E+00	-.1202E-02	.2098E+01	-.3165E-02
47.8000	-.1197E+02	.2644E-02	-.5340E+00	-.1142E-02	.2035E+01	-.3180E-02
47.8500	-.1198E+02	.2647E-02	-.5393E+00	-.1082E-02	.1968E+01	-.3195E-02
47.9000	-.1199E+02	.2650E-02	-.5434E+00	-.1020E-02	.1897E+01	-.3210E-02
47.9500	-.1199E+02	.2653E-02	-.5465E+00	-.9571E-03	.1824E+01	-.3225E-02
48.0000	-.1200E+02	.2656E-02	-.5484E+00	-.8932E-03	.1748E+01	-.3240E-02
48.0500	-.1201E+02	.2659E-02	-.5494E+00	-.8283E-03	.1669E+01	-.3254E-02
48.1000	-.1201E+02	.2662E-02	-.5492E+00	-.7626E-03	.1587E+01	-.3268E-02
48.1500	-.1202E+02	.2665E-02	-.5480E+00	-.6962E-03	.1503E+01	-.3282E-02
48.2000	-.1202E+02	.2668E-02	-.5459E+00	-.6292E-03	.1417E+01	-.3296E-02
48.2500	-.1203E+02	.2671E-02	-.5427E+00	-.5617E-03	.1328E+01	-.3310E-02
48.3000	-.1203E+02	.2675E-02	-.5386E+00	-.4938E-03	.1237E+01	-.3323E-02
48.3500	-.1204E+02	.2678E-02	-.5336E+00	-.4257E-03	.1145E+01	-.3336E-02
48.4000	-.1204E+02	.2681E-02	-.5276E+00	-.3573E-03	.1051E+01	-.3350E-02
48.4500	-.1204E+02	.2684E-02	-.5208E+00	-.2889E-03	.9553E+00	-.3363E-02
48.5000	-.1205E+02	.2687E-02	-.5132E+00	-.2204E-03	.8586E+00	-.3375E-02
48.5500	-.1205E+02	.2691E-02	-.5048E+00	-.1519E-03	.7609E+00	-.3388E-02
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48.6500	-.1206E+02	.2697E-02	-.4859E+00	-.1569E-04	.5632E+00	-.3412E-02
48.7000	-.1206E+02	.2700E-02	-.4754E+00	.5200E-04	.4637E+00	-.3424E-02
48.7500	-.1206E+02	.2704E-02	-.4644E+00	.1193E-03	.3641E+00	-.3436E-02
48.8000	-.1207E+02	.2707E-02	-.4528E+00	.1860E-03	.2645E+00	-.3448E-02
48.8500	-.1207E+02	.2710E-02	-.4408E+00	.2522E-03	.1652E+00	-.3459E-02
48.9000	-.1207E+02	.2713E-02	-.4282E+00	.3176E-03	.6621E-01	-.3471E-02
48.9500	-.1208E+02	.2717E-02	-.4153E+00	.3822E-03	-.3228E-01	-.3482E-02
49.0000	-.1208E+02	.2720E-02	-.4019E+00	.4460E-03	-.1301E+00	-.3493E-02
49.0500	-.1208E+02	.2723E-02	-.3882E+00	.5087E-03	-.2272E+00	-.3504E-02
49.1000	-.1209E+02	.2727E-02	-.3741E+00	.5704E-03	-.3234E+00	-.3514E-02
49.1500	-.1209E+02	.2730E-02	-.3598E+00	.6309E-03	-.4185E+00	-.3525E-02
49.2000	-.1209E+02	.2734E-02	-.3452E+00	.6902E-03	-.5124E+00	-.3535E-02
49.2500	-.1210E+02	.2737E-02	-.3303E+00	.7482E-03	-.6051E+00	-.3546E-02
49.3000	-.1210E+02	.2741E-02	-.3152E+00	.8048E-03	-.6964E+00	-.3556E-02
49.3500	-.1210E+02	.2745E-02	-.2999E+00	.8599E-03	-.7862E+00	-.3566E-02
49.4000	-.1211E+02	.2748E-02	-.2845E+00	.9134E-03	-.8744E+00	-.3576E-02
49.4500	-.1211E+02	.2752E-02	-.2689E+00	.9653E-03	-.9608E+00	-.3586E-02
49.5000	-.1212E+02	.2756E-02	-.2533E+00	.1015E-02	-.1045E+01	-.3595E-02
49.5500	-.1212E+02	.2760E-02	-.2375E+00	.1064E-02	-.1128E+01	-.3605E-02
49.6000	-.1213E+02	.2764E-02	-.2218E+00	.1110E-02	-.1209E+01	-.3614E-02
49.6500	-.1213E+02	.2768E-02	-.2060E+00	.1155E-02	-.1288E+01	-.3624E-02
49.7000	-.1214E+02	.2772E-02	-.1902E+00	.1198E-02	-.1364E+01	-.3633E-02
49.7500	-.1214E+02	.2776E-02	-.1744E+00	.1239E-02	-.1438E+01	-.3642E-02
49.8000	-.1215E+02	.2780E-02	-.1588E+00	.1278E-02	-.1510E+01	-.3651E-02
49.8500	-.1216E+02	.2784E-02	-.1432E+00	.1314E-02	-.1579E+01	-.3660E-02
49.9000	-.1216E+02	.2789E-02	-.1277E+00	.1349E-02	-.1645E+01	-.3670E-02
49.9500	-.1217E+02	.2793E-02	-.1123E+00	.1382E-02	-.1709E+01	-.3679E-02
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50.0500	-.1219E+02	.2802E-02	-.8202E-01	.1441E-02	-.1830E+01	-.3697E-02
50.1000	-.1220E+02	.2807E-02	-.6710E-01	.1468E-02	-.1886E+01	-.3706E-02
50.1500	-.1221E+02	.2811E-02	-.5233E-01	.1492E-02	-.1939E+01	-.3716E-02
50.2000	-.1222E+02	.2816E-02	-.3773E-01	.1514E-02	-.1990E+01	-.3725E-02
50.2500	-.1223E+02	.2821E-02	-.2330E-01	.1534E-02	-.2038E+01	-.3735E-02
50.3000	-.1224E+02	.2826E-02	-.9034E-02	.1552E-02	-.2083E+01	-.3744E-02
50.3500	-.1225E+02	.2831E-02	.5058E-02	.1568E-02	-.2126E+01	-.3754E-02
50.4000	-.1226E+02	.2836E-02	.1898E-01	.1581E-02	-.2166E+01	-.3764E-02
50.4500	-.1227E+02	.2842E-02	.3274E-01	.1593E-02	-.2203E+01	-.3774E-02
50.5000	-.1229E+02	.2847E-02	.4633E-01	.1602E-02	-.2237E+01	-.3784E-02
50.5500	-.1230E+02	.2853E-02	.5976E-01	.1609E-02	-.2269E+01	-.3795E-02
50.6000	-.1231E+02	.2859E-02	.7304E-01	.1614E-02	-.2298E+01	-.3805E-02
50.6500	-.1233E+02	.2865E-02	.8616E-01	.1617E-02	-.2324E+01	-.3816E-02
50.7000	-.1235E+02	.2872E-02	.9913E-01	.1617E-02	-.2348E+01	-.3827E-02
50.7500	-.1236E+02	.2879E-02	.1120E+00	.1616E-02	-.2369E+01	-.3838E-02
50.8000	-.1238E+02	.2886E-02	.1246E+00	.1612E-02	-.2388E+01	-.3849E-02
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50.9500	-.1244E+02	.2908E-02	.1620E+00	.1588E-02	-.2427E+01	-.3884E-02
51.0000	-.1246E+02	.2916E-02	.1741E+00	.1576E-02	-.2436E+01	-.3896E-02
51.0500	-.1248E+02	.2924E-02	.1862E+00	.1562E-02	-.2441E+01	-.3908E-02
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.330765E+04  -.335098E+04  -.341832E+04  -.348701E+04  -.394108E+04  -.395369E+04  -.396608E+
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.316751E+04  -.320910E+04  -.327484E+04  -.334180E+04  -.389189E+04  -.390428E+04  -.391540E+
04  -.393728E+04  -.398332E+04  -.405314E+04  -.412778E+04  -.436053E+04  -.437488E+04  -.439
262E+04  -.441982E+04  -.447027E+04  -.454412E+04  -.462470E+04  -.451423E+04  -.453022E+04
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0E+03  .178653E+04  .178477E+04  .177797E+04  .177146E+04  .176874E+04  .177120E+04  .
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65E+04  .428309E+04  .492749E+04  .492761E+04  .492522E+04  .492738E+04  .493467E+04
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SEALOADS is a computer software package for the time-domain prediction of nonlinear ship motions, hydrodynamic hull pressures, and sea loads. This manual explains how to use the program.

The SEALOADS code consists of three modules. One module computes time-domain hydrodynamic coefficients and the impulsive response functions of the forces and pressures due to the radiated waves. Another module solves the time-domain response functions of the forces and pressures due to diffracted waves. The main program module computes ship motions, hydrodynamic pressure distribution on the ship hull, and sea loads in the time domain.

The SEALOAD code is written for use with a FreeBSD UNIX system. A flow chart and procedures for running the package are included. Input and output file structures are described in detail. Example files are also included in the report.

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